

CLAIMS

WE CLAIM:

1. A front frame structure for a vehicle, attached to side rails of
5 the vehicle, for absorbing energy during a frontal collision of the vehicle, the front
frame structure comprising:

a bumper reinforcement disposed at a front end of the frame
structure and extending transversely to a longitudinal centerline of the vehicle;
and

10 a pair of juxtaposed main frame rails extending longitudinally along
the longitudinal centerline of the vehicle, each main frame rail having a front end
thereof attached to the bumper reinforcement and a rear end thereof attached to
a respective side rail of the vehicle;

each main frame rail having a deformable forward section, a non-
15 deformable intermediate section and a non-deformable rear section thereof,
each of the forward, intermediate and rear sections of each main frame rail
defining a front and a rear end thereof;

the forward section of each main frame rail being joined at the front
end thereof to the bumper reinforcement and at the rear end thereof to the front
20 end of the intermediate section of that main frame rail;

the rear section of each main frame rail being joined at the front
end thereof to the rear end of the intermediate section of that main frame rail and
at the rear end thereof to the respective side rail of the vehicle;

each main frame rail further including a first selectively crushable
25 juncture joining the rear end of the forward section of that main frame rail to the
front end of the intermediate section of that frame rail, a second selectively
crushable juncture joining the rear end of the intermediate section of that frame
rail to the front end of the rear section of that main frame rail, and a third
selectively crushable juncture between the rear end of the rear section of that

main frame rail and the respective side rail of the vehicle;

one or more of the first, second, and third selectively crushable
junctures predisposing at least one of the second selectively crushable junctures
to pivot outward with respect to the longitudinal centerline during a frontal
5 collision of the vehicle.

2. The front frame structure of claim 1 wherein at least one of
the selectively crushable junctures comprises a rectangular box frame structure
having one or more generally longitudinally oriented elongated stiffening ribs
10 embossed into a wall of one surface of the rectangular box frame structure, to
thereby predispose the selectively crushable juncture to bend in a preferred
direction during a frontal collision of the vehicle.

3. The front frame structure of claim 1, wherein one or more of
15 the selectively crushable junctures further predisposes the forward end of at
least one of the rear sections to pivot rearward during a frontal collision of the
vehicle.

4. The front frame structure of claim 1, wherein one or more of
20 the selectively crushable junctures further predisposes at least one of the second
selectively crushable junctures to pivot upward during a frontal collision of the
vehicle.

5. The front frame structure of claim 4, wherein one or more of
25 the selectively crushable junctures further predisposes the front end of at least
one of the rear sections to pivot rearward during a frontal collision of the vehicle.

6. The front frame structure of claim 5 wherein, for each main
frame rail, the front section is predisposed to deform first, the second juncture is

predisposed to pivot outward and upward second, and the front end of the rear section is predisposed to pivot rearward last during a frontal collision of the vehicle.

5 7. The front frame structure of claim 6, further comprising, an engine cradle disposed below the main frame rails and having a pair of longitudinally extending side rails, each engine cradle side rail being attached at a front end thereof to the forward section of one of the main frame rails and attached at a rear end thereof to the vehicle at rear attachment point of the
10 cradle disposed adjacent the rear end of the rear section of the one of the main frame rails.

 8. The front frame structure of claim 7, wherein each of the engine cradle side rails includes a front and a rear selectively crushable juncture
15 joined by a non-deformable intermediate section of that engine cradle side rail, the front and rear selectively crushable junctures of the engine cradle side rails predisposing the intermediate sections of the engine cradle to move downward and rearward during a frontal collision of the vehicle.

20 9. The front frame structure of claim 8, wherein at least one of the selectively crushable junctures of the engine cradle side rails comprises a rectangular box frame structure having a bend initiating dimple extending transversely across one surface of the rectangular box frame structure and a pair
25 of longitudinally extending slots adjacent the bend initiating dimple in one or more of the adjoining surfaces of the rectangular box frame structure.

10. A front frame structure for a vehicle, attached to side rails of the vehicle, for absorbing energy during a frontal collision of the vehicle, the front frame structure comprising:

5 a bumper reinforcement disposed at a front end of the frame structure and extending transversely to a longitudinal centerline of the vehicle;

a pair of juxtaposed main frame rails extending longitudinally along the longitudinal centerline of the vehicle, each main frame rail having a front end thereof attached to the bumper reinforcement and a rear end thereof attached to a respective side rail of the vehicle; and

10 an engine cradle disposed below the main frame rails and having a pair of longitudinally extending side rails;

each main frame rail having a deformable forward section, a non-deformable intermediate section and a non-deformable rear section thereof, each of the forward, intermediate and rear sections of each main frame rail
15 defining a forward and a rear end thereof;

the forward section of each main frame rail being joined at the front end thereof to the bumper reinforcement and at the rear end thereof to the forward end of the intermediate section of that main frame rail;

the front end of the rear section of each main frame rail being
20 joined at the forward end thereof to the rear end of the intermediate section of that main frame rail and at the rear end thereof to the respective side rail of the vehicle;

each main frame rail further including a first selectively crushable juncture joining the rear end of the forward section of that main frame rail to the
25 front end of the intermediate section of that main frame rail, a second selectively crushable juncture joining the rear end of the intermediate section of that main frame rail to the front end of the rear section of that main frame rail, and a third selectively crushable juncture between the rear end of the rear section of that main frame rail and the respective side rail of the vehicle;

one or more of the first, second, and third selectively crushable junctures providing for at least one of the second selectively crushable junctures to pivot outward with respect to the longitudinal centerline during a frontal collision of the vehicle;

5 each engine cradle side rail being attached at a forward end thereof to the forward section of a respective main frame rail and attached at a rear end thereof to the vehicle at rear attachment point of the cradle disposed adjacent the rear end of the rear section of the respective main frame rail.

10 11. The front frame structure of claim 10 wherein at least one of the selectively crushable junctures comprises a rectangular box frame structure having one or more generally longitudinally oriented elongated stiffening ribs embossed into a wall of one surface of the rectangular box frame structure, to thereby predispose the selectively crushable juncture to bend in a preferred
15 direction during a frontal collision of the vehicle.

 12. The front frame structure of claim 11, wherein the front and rear ends of the engine cradle side rails include a front and a rear selectively crushable juncture joined by a non-deformable intermediate section, the front
20 and rear selectively crushable junctures of each engine cradle side rail predisposing the intermediate section of the engine cradle side rail to move downward and rearward during a frontal collision of the vehicle.

 13. The front frame structure of claim 12, wherein at least one of
25 the selectively crushable junctures of the engine cradle comprises a rectangular box frame structure having a bend initiating dimple extending transversely across one surface of the rectangular box frame structure and a pair of longitudinally extending slots adjacent the bend initiating dimple in one or more of the adjoining surfaces of the rectangular box frame structure.

14. The front frame structure of claim 12, wherein one or more of the selectively crushable junctures further predisposes the forward end of at least one of the rear sections to pivot rearward during a frontal collision of the vehicle.

15. The front frame structure of claim 14, wherein one or more of the selectively crushable junctures further predisposes at least one of the second selectively crushable junctures to pivot upward during a frontal collision of the vehicle.

16. The front frame structure of claim 15, wherein one or more of the selectively crushable junctures further predisposes the front end of at least one of the rear sections to pivot rearward during a frontal collision of the vehicle.

17. The front frame structure of claim 16 wherein for each main frame rail, the front section is predisposed to deform first, the second juncture is predisposed to pivot outward and upward second, the intermediate section of the engine cradle is predisposed to move downward third, and the forward end of the rear section is predisposed to pivot rearward last, during a frontal collision of the vehicle.

18. A method for absorbing energy during a frontal collision of the vehicle, the method comprising:
constructing the vehicle to include a front frame structure having a bumper reinforcement and a pair of juxtaposed main frame rails, with the bumper reinforcement disposed at a front end of the frame structure and extending transversely to a longitudinal centerline of the vehicle and the pair of juxtaposed main frame rails extending longitudinally along the longitudinal centerline of the

vehicle, each main frame rail having a front end thereof attached to the bumper reinforcement and a rear end thereof attached to a respective side rail of the vehicle, each main frame rail also having a deformable forward section, a non-deformable intermediate section and a non-deformable rear section thereof, each of the forward, intermediate and rear sections of each main frame rail defining a front and a rear end thereof, with the forward section of each main frame rail being joined at the front end thereof to the bumper reinforcement and at the rear end thereof to the front end of the intermediate section of that main frame rail, the rear section of that main frame rail being joined at the front end thereof to the rear end of the intermediate section of that main frame rail and at the rear end thereof to the respective side rail of the vehicle, with each main frame rail further including a first selectively crushable juncture joining the rear end of the forward section of that main frame rail to the front end of the intermediate section of that main frame rail, a second selectively crushable juncture joining the rear end of the intermediate section of that main frame rail to the front end of the rear section of that main frame rail, and a third selectively crushable juncture between the rear end of the rear section and the respective side rail of the vehicle; and

configuring one or more of the first, second, and third selectively crushable junctures to predispose at least one of the second selectively crushable junctures to pivot outward with respect to the longitudinal centerline during a frontal collision of the vehicle.

19. The method of claim 18, further comprising, configuring one or more of the selectively crushable junctures to predispose the front end of at least one of the rear sections to pivot rearward during a frontal collision of the vehicle.

20. The method of claim 19, further comprising, configuring one or more of the selectively crushable junctures to predispose at least one of the second selectively crushable junctures to pivot upward during a frontal collision of the vehicle.

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